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(54) METHOD AND APPARATUS FOR COLD HEADING BLANKS

(54)

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ABSTRACT:

CLAIMS: Show all claims

*** Note: Data on abstracts and claims is shown in the official language in which it was submitted.

(72) Inventors (Country):	**ROBERT G. FRIEDMAN** (Not Available)
(73) Owners (Country):	**THE NATIONAL MACHINERY COMPANY**
(71) Applicants (Country):	
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This invention r lates to a method and an apparatus for cold heading a blank for a bolt, screw, or the like, and to a cold headed blank produced thereby.

Forging or heading machines of the type known as double blow headers have been used to cold form various metal articles. Generally speaking, a double blow header comprises a die block through which round wire or rod stock is fed intermittently, a timed shearing mechanism for shearing off a predetermined length of the stock ro provide a blank or workpiece, a transfer mechanism for positioning such blank in front of a forming die, and a header slide carrying two forming tools, a coning tool and a heading tool, which apply successive blows against the blank while the blank is held in the forming die. The header slide is reciprocated toward and away from the forming die, and the two heading tools are mounted on a shifting punch carrier which presents the tools alternately to the blank, so that first the coning tool strikes the blank to gather the stock and then the heading tool strikes the blank to finish the heading operation.

On such machines, two blows are used to permit forming a larger head than could be formed in a single blow, since if the length of stock necessary to provide the desired volume for the head were struck initially by the finish heading tool, the stock would buckle and bend instead of upsetting. Accordingly, the usual coning tool surrounds and confines the outer end of the stock and upsets against the die only a part of the protruding length of the blank, and the second tool then upsets the remaining length. While this permits gathering more stock and the making of the desired size head, it is accompanied by the disadvantage of a re-entrant folding of the metal between the tw ups ts, pr ducing a weakened plan through the head. The great r the amount of upsetting in th first or coning blow, th greater th amount of rev rse folding that occurs, and

the w aker the finished head.

In the making of polygonal double-blow heads from ordinary round wire or rod stock, it has been necessary heretofore to upset the stock into an enlargement circular in cross-section with the desire axial length and a diameter slightly greater than the diameter across the flats of the desired finished head, and then cut away the peripheral portion with a polygonal trimming die. This involves a waste of the material trimmed from the head, and also aggravates the weakness from the re-entrant folding of the metal, since it is necessary to gather a volume of stock equal to the volume of the finished head plus the volume of the metal trimmed away.

According to the present invention, the entire length of stock necessary to provide the desired volume in the finished head is upset in each of two successive blows, first to a form similar to the desired finished head but of smaller cross-section and greater axial length, and second to the desired finished polygonal head without flash or waste.

By upsetting the entire protruding length of the stock in the first blow, flowing the metal only in the directions in which it must move to reach the finished shape, and again upsetting the entire volume in the second blow, flowing the metal farther, but only in the same directions in which it moved in the first blow, a finished full-sized polygonal head may be produced without any re-entrant folding or flowing of the metal, without the necessity of a subsequent trimming operation, and without waste.

This operation has been made possible according to the present invention by surrounding the necessary unsupported length of stock, in the first blow of the header, by a polygonal enclosure similar to the d sired polyg nal shape of th finished h ad, but with a diamet r across the flats of the polygonal enclosur only slightly greater than the diameter of th round

wir stock so as to pr vent the stock from buckling and bending, and th n upsetting the stock axially into the polygonal enclosure. The resulting head portion, with an axial length small enough in proportion to its diameter across the flats to upset without buckling, the axial length preferably being not more than 2-1/4 times the diameter across the flats, is then upset in the second blow of the header into the desired finished form and dimension by a heading tool having a recess shaped to form the side faces and top face of the finished head.

It is an object of this invention to provide a novel and improved cold-headed blank for a bolt, screw or the like.

It is also an object of this invention to provide a novel and improved method of cold heading which produces a finished polygonal head on a round cross-section blank in a double blow header.

Another object of this invention is to provide a novel and improved arrangement in a double blow header which enables the cold forming of a polygonal head on a ground cross-section blank in just the two blows of the header.

Another object of this invention is to provide a novel arrangement for cold forming a polygonal head on round stock which avoids weakening of the head.

Another object of this invention is to provide a novel arrangement for cold forming a polygonal head on round stock which avoids waste of the stock material and which avoids the need for any subsequent trimming operations on the head.

Further objects and advantages of this invention will be apparent from the following detailed description of two presently-preferred embodiments thereof, which are illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a sectional vi w taken transversely through a double blow header which incorporates the present invention, showing the position of the parts during the first

forward stroke of the header slide;

Fig. 2 is a similar view showing the position of the parts later on in the first strok of the header slide;

Fig. 3 is a similar view showing the position of the parts at the end of the first forward stroke of the header slide;

Fig. 4 is a similar view showing the position of the parts as the header slide is retracted following its first forward stroke;

Fig. 5 is a similar view showing the position of the parts during the second forward stroke of the header slide, at which time the finish punch is positioned for operation against the blank;

Fig. 6 is a similar view showing the position of the parts at the end of the second forward stroke of the header slide;

Fig. 7 is a similar view showing the position of the parts when the header slide is retracted following its second forward stroke;

Fig. 8 is a fragmentary transverse sectional view showing a second embodiment of the present apparatus, with the header slide moving forward in its first stroke;

Fig. 9 is a similar view showing the position of the parts at the end of the first forward stroke of the header slide in Fig. 8;

Fig. 10 is a similar view showing the position of the parts during the second forward stroke of the header slide, at which time the finish punch is positioned to act on the blank;

Fig. 11 is a similar view showing the position of the parts at the end of the second forward stroke of the header slide; and

Fig. 12 is an axial section of a cold-headed blank in accordance with this invention.

R ferring first to the embodim nt shown in Figs. 1-7,

the double blow header includ s a single work-receiving di 20 formed with a cylindrical bore or cavity. When it is desir d to make a b lt with a washer face on the underside of the head, as in the illustrated embodiment, a cylindrical counterbore 22, which is coaxial with the cavity 21, is formed at the front face 23 of the die. A knock-out pin 24 is reciprocably mounted in the die at the back end of the cavity 21. During the double blow heading operation on the workpiece or blank, this pin 24 remains stationary in the die so as to provide a fixed abutment for engagement by the inner end of the blank or workpiece.

The blank 25 is a predetermined length of round rod, which has been sheared from the wire or rod stock by the usual shearing mechanism (not shown) which is part of the double blow header apparatus. After having been sheared off from the rod stock, this blank 25 is positioned by the usual transfer mechanism (not shown) in front of the die cavity 21.

Referring now to Fig. 1, the double blow header includes the usual header slide 26 which is mounted for reciprocation toward and away from the die 20. Shiftably mounted on the header slide is a tool carrier 27, which in turn carries a cone tool and a finish tool for imparting the first and second blows against the blank. The tool carrier is adapted to be shifted to align the two tools alternately with the die cavity 21 during alternate reciprocations of the header slide 26. Any suitable shifting mechanism may be used, preferably that shown in my U.S. patent No. 3,031,698, dated May 1, 1961, or that shown in U.S. Patent No. 1,932,396, to Clouse, dated

The cone tool is designated in its entirety by the reference numeral 28 to Fig. 1. It comprises a generally sleeve-like member 29 having an enlarged, cylindrical, transverse flange 30 on its front end. The sleeve-like member 29 is slidably mounted in a bushing 31 carri d by the tool holder 27. A punch guide 32 is seated in the back end of the bushing

31 behind th back end of the sleeve member 29. The punch guid 32 is stationary with respect to the tool holder 27 at all times. At its back end the sleeve member 29 of the cone tool is formed with a counterbore 33. A coil spring 34 is received in this counterbore and is engaged under compression between the sleeve member 29 and the punch guide 32, biasing the cone tool 28 forward with respect to the tool holder 27.

At its front end the sleeve member 29 carries a punch die 35. The punch die 35 is formed with a lengthwise cavity 36 which is hexagonal in cross-section. At its front end the punch die 35 presents a cylindrical nose 37 projects beyond the front face of the flange 30 on the sleeve member 29 and which is shaped and dimensioned to be snugly, but slidably, received in the counterbore 22 in the die 20.

A filler or back-up plate 38 is engaged between the back end of the punch die 35 and an internal transverse shoulder 39 formed in the sleeve member 29.

The cone tool also includes a punch 40 which is hexagonal in cross-section and is arranged to be slidably, but snugly, received in the hexagonal cavity 36 in the punch die 35. Approximately midway along its length the punch 40 is formed with an enlarged portion 41, which is positioned to abut against the reduced front end 42 of the punch guide 32. Behind this enlarged portion 41 the punch is formed with a reduced diameter cylindrical stem 43 which extends slidably through the punch guide 32. A knock-out lever 44, which is pivotally mounted on a part 27a of the tool holder 27, is positioned to engage the back end of this stem 43, as shown in Fig. 1, when the cone tool 28 is aligned with the die cavity 21.

The sleeve member 29 in the cone tool is formed with a l ngthwise slot 45 in its periphery. A st p pin 46 carri d by the tool holder 27 is engaged in this slot. The length of the slot 45 in a direction parall l to the direction of mov ment of

th head r slide is substantially longer than the corresponding length of the portion of the stop pin 46 which is r ceived in this slot, so that the cone tool 28 is abl to slide axially with respect to the tool holder 27 and the header slide 26 by an amount determined by these dimensions of the slot 45 and the stop pin 46. Normally, as shown in Fig. 1, the spring 34 biases the cone tool 28 forwardly with respect to the tool holder 27.

Fig. 1 shows the position of the parts during the first forward stroke of the header slide. The inner end of the blank 25 is tightly received in the work-receiving die 20 while its outer end is loosely received in the cavity 36 in the punch die. The outer, or right, end of the blank is engaged by the front end of the punch 40, so that the blank is pushed into the die cavity 21 in response to the forward movement of the header slide 26 in its first stroke.

Fig. 2 shows the position of the parts later on in the first forward stroke of the header slide, when the cone tool engages the front face 23 of the die 20. At this time the nose 37 on the front end of the punch die 35 is snugly received in the counterbore 22 in the die 20. The inner or left end of the blank 25 engages the knock-out pin 24 in the die 20, while its opposite end is engaged by the front end of the punch 40.

Upon continued forward movement of the header slide and the tool holder 27 the punch 40 is caused to move forward into the hexagonal cavity 36 in the punch die 35. At this time the cone tool and the punch die 35 which it carries are held stationary by virtue of their engagement against the fixedly positioned die 20. However, the tool holder 27 and the header slide 26 can continue to move forward by an amount determined by the length of the slot 45. The spring 34 becomes compressed further during this over-travel of th tool hold r 27 and th header slid 26 with r spect to the cone tool 28. The knock-out lever 44 remains stationary on the tool holder 27 throughout

the first forward stroke of the header slide. During the compl tion of the forward str k of the head r slid (Fig. 3), the punch 40 upsets the outer, or right, end of the blank 25 and cold forms the latter into a hexagonal cross-section segment 25a which tightly fills the hexagonal cavity 36 in the punch die 35. In this operation, since the blank 25 is of round stock to begin with, the metal in the stock first upsets to a round and contacts tangentially the flat sides of the punch die cavity 36 which support the stock against buckling. Thereafter the metal in the stock fills in the corners of this die cavity. As a result, the die cavity is rather tightly packed at the end of the upsetting operation.

I have found that a critical factor in the operation which takes place during this first blow, as just described, is that the across-the flats width of the die cavity 36 in the punch die 35 should not be greater than 1-1/2 times, and preferably only 1-1/4 times the diameter of the initial blank 25, when the volume of the head is such that a length of stock more than 2-1/2 times the diameter must be upset. If this critical dimension is not exceeded, then the blank is restrained against buckling because of the support provided by the flats in the die cavity. Therefore, no re-entrant fold is formed in the upset portion of the blank and the blank proceeds to fill in the corners of the die cavity.

Thus, in the first, or coning, blow of the header the blank is upset into a head segment having the general polygonal shape of the desired finished head, but smaller in cross-section and longer axially. This initial upsetting of the blank from round cross-section into a enlarged segment of the general polygonal shape desired makes possible the final upsetting which takes place in the second blow of the header.

At the completion of the first blow, the head r slide 26 is retracted b ck away from the die 20. During the initial

retracting movement of the header slide 26 and the tool holder 27, which moves in unison with it, the front end of the cone tool 28 remains in engagement with the front face 23 of the die 20 due to the urging of the spring 34. However, when the tool holder 27 has retracted a distance determined by the slot 45, the stop pin 46 again couples the cone tool 28 to the tool holder 27, so that upon continued retraction of the header slide the cone tool 28 moves back away from the die 20.

As the header slide starts its retracting motion from forward dead center, the knock-out lever 44 is actuated pivotally relative to the tool holder 27 such that the punch-engaging portion of this lever moves forward at substantially the same rate of speed as the header slide 26 and tool holder 27 are being retracted, so that the punch 40 remains substantially stationary against the end of the upset 25a until the cone tool 28 has been moved back and stripped from the upset 25a, as shown in Fig. 4. This knock-out movement of the punch 40 is necessary to disengage the blank from the punch die 35 because of the fact that the hexagonal portion 25a of the blank fills the cavity in the punch die 35 quite snugly. Any suitable mechanism may be used for actuating the lever 44, preferably the mechanism shown in my U. S. Patent 3,031,698, or U.S. patent No. 2,271,257 to J. H. Friedman.

From Fig. 4 it will be apparent that the blank remains seated in the die 20 during the retraction of the header slide after its first stroke.

Before the second forward stroke of the header slide, the tool carrier 27 is shifted on the header slide 26 so as to move the cone tool 28 out of alignment with the die 21 and move into alignment with the die 21 a finish punch tool 50 for engagement with the blank in the next forward stroke of the header slide, in the position shown in Fig. 5. At the same time, the tool carrier 27 moves a knock-out lever 44', which is

pivoted on a part 27b of the tool carrier 27, to the position shown in Fig. 5.

Referring now to Fig. 5, the finish punch tool 50 includes a sleeve member 51 having an enlarged flange 52 on its front end. The sleeve member 51 is snugly received in a cylindrical bushing 49 carried by the tool carrier 27.

A punch guide 53 is snugly received in the back end of the bushing 49. At its front end the punch guide 53 is formed with a reduced diameter nose 54. A rigid annular filler plate 55 is engaged between the front of the punch guide 53 and an internal, rearwardly-facing shoulder 56 formed on the finish punch 50. With this arrangement, the finish punch 50 moves as a rigid unit with the header slide 26 and the tool carrier 27.

At its front end the finish tool 50 carries a punch die 57 having a hexagonal die cavity 58 therein. The size of this die cavity 58 determines the size of the finished hex head on the blank. A knock-out pin 59 at its front end presents and enlarged, generally conical head 60 which is snugly, but slidably, disposed in the punch die cavity 58. This head 60 is formed with spaced, forwardly projecting petals 61 at its periphery and a rearwardly curved edge between each pair of neighboring petals to form the rounded edges between the corners on the finished head on the blank.

A hexagonal back-up plate 62 is tightly received in the punch die 57 directly behind the head 60 on the knock-out pin 59. This back-up plate is formed with a central, axial bore 63 which slidably receives the shank of the knock-out pin 59. The back-up plate 62 also presents a forwardly facing conical surface 64 which is snugly complementary to the conical back end of the head 60 on the knock-out pin.

Just forward of its rearwardly-facing internal shoulder 56 the sleeve member 51 of the finish punch has a radially

inwardly protruding segment 71 formed with a plurality of lengthwise holes 65 and an axial bor 66 which slidably receives the shank of the knock-out pin 59. An annular plate 67, which slidably receives the shank of the knock-out pin 59, is engaged between the front end of this radially inwardly protruding portion 71 of the sleeve member 51 and the back end of the punch die 57 and the back-up place 62 therein.

At the back end of the knock-out pin 59 a larger diameter pin 68 is snugly, but slidably, received in an axial bore 69 in the guide plate 53. The length of the pin 68 is equal to the axial length of the guide plate 53. The back end of this pin 68 is engaged by the knock-out lever 44', which is pivotally mounted on the tool carrier 27. The front end of the pin 68 engages the back face of a sleeve 72, which is slidably mounted in the annular plate 55. From Fig. 5 it will be apparent that the axial length of the sleeve 72 is substantially less than the axial length of the plate 55, so that the sleeve 72 is able to slide axially a predetermined distance within the plate 55. This happens when the pin 68 is moved forward by the knock-out lever 44', as described in detail hereinafter.

Fig. 5 shows the position of the parts during the first portion of the forward movement of the header slide 26 in its second stroke. The finish punch 50 and the tool carrier 27 move forward in unison with the header slide 26 at this time.

When the enlarged head 60 on the knock-out pin 59 engages the outer end face of the hexagonal, upset portion 25a on the blank 25, during the continued forward movement of the header slide, it causes the hexagonal portion 25a to be upset further to the final hex head shape 25c shown in Fig. 6. This upsetting action takes place completely within the punch die cavity 58 and the cylindrical counterbore 22 in the die 20. As a result of this action, a cylindrical collar 25b is formed on the blank just forward of the finished hexagonal head 25c.

I have found that a critical factor in the successful operation of this mbodim nt of the pr sent invention is that the axial l ngth of the hexagonal segment 29a, which is to be ups t in the second blow of the header, should not be more than 2-1/4 times the across-the flats dimension of the finished hex head 25c. This prevents buckling of the stock as it is being upset to its final shape, which is appreciably shorter axially and larger in cross-section.

During the upsetting of the metal in the second blow of the header, the conical front end face 64 of the back-up plate 62, which fits tightly in the punch die 57, supports the enlarged head 60 on the knock-out pin, particularly at the petals 61 thereon which form the chamfer on the corners of the head on the blank. Because of this, the head 60 on the knock-out pin is sealed around its entire periphery and no flash can form.

In both upsetting blows the blank has no tendency to buckle and the upsetting action proceeds in the desired manner, completely avoiding the formation of a re-antrant fold in the upset head. Also, in both blows the upset metal flows in the same direction, the flow which takes place in the second blow being essential an extension of the flow which occurred in the first blow. The end result is that the head is completely finished in just two blows and has improved strength.

At the completion of the second blow the header slide 26 is again retracted, carrying with it the tool carrier 27 and the finish punch 50. At this time the knock-out lever 44' is operated in its forward stroke to push the pin 68 forward. The pin 68 engages the sleeve 72 and the knock-out pin 59 and forces them forward until the sleeve 72 strikes the radially inwardly protruding mid-portion 71 of the sleeve member 51. This limits the extent to which the knock-out pin 59 can move forward with respect to the finish punch 50. During this movement of the knock-out pin 59 its head 60 pushes the finished hex head 25c on th

blank out of the punch die cavity 58 and maintains the blank seated in the cavity 21 in the fixed die 20.

After the header slide 26 has been retracted a sufficient amount, the knock-out pin 24 in the fixed die 20 is actuated forward to knock the finished blank out of the die cavity 21 therein.

Following this, and before the next forward stroke of the header slide 26, another length of the wire stock is sheared off and is moved into position in front of the die cavity 21, so that in the next forward stroke of the header slide this next blank is upset in the manner shown in Figs. 1-4.

The headed blank produced by the just-described apparatus and process is suitable as a cap screw whose shank 25 may be threaded up to the finished hex head.

This particular embodiment is particularly suitable where the cross-sectional size of the finished head is to be rather large compared to the original diameter of the blank.

In one suitable practical embodiment of this form of the invention the starting blank is of .270 inch diameter wire, the upset hex head segment 25a after the first blow has an across-the-flats width of about .315 inch and the finished hex head 25c (after the second blow) has an across-the -flats width of about .495 inch and an axial length of about .193 inch.

When it is desired to make a bolt with a shank portion adjacent the head having a diameter equal to the over-all diameter of the threads to be formed on the remainder of the shank, it is possible to simplify the apparatus and perform more of the upsetting in the first blow, because larger diameter stock may be used so that a shorter length supplies the necessary volume for the finished head. This is illustrated in the second embodiment of the present invention, shown in Figs. 8-11. The fixed die in the h ader frame is designat d in its entirety by the referenc numeral 80. This die is formed with a cylindrical

bore 81 which slidably receives a knock-out pin 82. At its forward end the bore 81 leads into a short frusto-conical bore section 83 which is of increasing diameter toward the front of the fixed die, constituting an extrusion throat. At its front end the frusto-conical bore section 83 leads into a cylindrical bore section 85 of larger diameter than the bore 81. A cylindrical counterbore 86 is formed in the front end face 84 of the fixed when it is desired to form a washer face on the underside of the head.

Prior to the first stroke of the header slide in the apparatus of Fig. 8, a blank of round bar or wire stock is positioned in front of the cavity 86, 85, 83, 81 in the fixed die 80 in the same manner as in the first embodiment.

The header slide 87 carries a shiftable tool holder 88 which, in turn, carries a cone tool designated in its entirety by the reference numeral 89, shown in alignment with the die in Figs. 8 and 9. The cone tool comprises a sleeve member 90 which is slidably received in a cylindrical bushing 91 carried by the tool holder 88. At the front end the sleeve member has an enlarged transverse flange 92.

A punch guide 93 is seated in the back end of the bushing 91 behind the back end of the sleeve member 90. This punch guide is stationary with respect to the tool holder 88 at all times.

At its back end the sleeve member 90 of the cone tool is formed with a counterbore 94 which loosely receives the reduced diameter front end 95 of the punch guide 93. A coil spring 96 is received in this counterbore and is engaged under compression between the sleeve member 90 and the punch guide 93, biasing the cone tool 89 forward with respect to the tool holder 88.

At its front end the sleeve member 90 carries a punch die 97. The punch die is formed with a lengthwise cavity 98 which is hexagonal in cross-section. The front end of the punch

die 97 is flush with the front end face of the sleev member 90. The punch die 97 is snugly seated in a complementary rec ss 99 formed in th sleeve memb r 90. Between its recess 99 at its front end and its counterbore 94 at its back end the sleeve member 90 presents a radially inwardly protruding, annular portion 100 which extends around an axial opening 101 which joins the cavity 99 to the counterbore 94.

The cone tool also includes a punch 102 which is hexagonal in cross-section and which is arranged to be slidably, but snugly, received in the hexagonal cavity 98 in the punch die 97. As shown in Fig. 8, the hexagonal front end of the punch extends loosely through the opening 101 and into the cavity in the punch die 97. At its front end the punch may be formed with a shallow recess 103, for a purpose which will be explained hereinafter.

Approximately midway along its length the punch 102 presents a cylindrical portion 104, and behind that a reduced diameter cylindrical stem 105. The back end of the punch portion 104 is disposed just in front of the reduced diameter front end 95 of the punch guide 93. The smaller diameter stem 105 on the punch is snugly, but slidably, received in an axial bore 106 in the punch guide 93, so that the punch is guided by the punch guide 93. A knock-out lever 107, which is pivotally mounted a part 88a of the tool holder 88, is positioned to engage the back end of the punch stem 105, as shown in Fig. 8, when the cone tool is in alignment with the die.

The sleeve member 90 in the cone tool is formed with a short lengthwise slot 108 in its periphery. A transversely disposed stop pin 109 carried by the tool holder 88 is engaged in this slot. The axial length of this slot determines the distance which the tool holder 88 can move with respect to the cone tool 89, as in the first embodiment of this invention. Normally, as shown in Fig. 8, the spring 96 biases the cone t ol

89 forwardly with respect to the tool holder 88 so that the stop pin 109 engages the back end of the slot 108 in the cone tool.

In this embodiment of the present invention the blank which is cut from round rod stock initially has a diameter substantially equal to that of the cylindrical bore section 85 in the fixed die 80.

Prior to the first forward stroke of the header slide 87, this workpiece W is positioned in front of the cavity in die 80.

As the header slide 87 moves forward in its first stroke, it carries with it the cone tool 89. The punch die 97 moves forward, loosely surrounding the outer, or right, end of the blank W. When the punch 102 carried by the header slide 87 engages the outer end face of the blank W, it begins to slide the blank into the cavity in die 80. The inner end 110 of the blank W is extruded through the extrusion throat 83 of the fixed die cavity and extends into the smaller diameter cylindrical portion 81 of the fixed die cavity. This action continues during the continued forward movement of the header slide 87, until the front end of the workpiece W engages the now fixedly positioned knock-out pin 82 in the die 80. The condition of the parts at this time is shown in Fig. 8.

As the header slide 87 continues to move forward, carrying with it the cone tool 89, the outer end portion 111 of the workpiece W is upset so as to fill the hexagonal cavity 98 in the punch die 97 and also to fill the cylindrical counterbore 86 in the front end of the fixed die 80. When the unsupported length 111 of the blank approaches or exceeds slightly the critical limits of this embodiment, it is preferable to include the recess 103 in the front end of the punch 102, so that the portion 111 of the workpiece which is being upset is supported from b th ends.

In this upsetting operation, since the blank W is of

round stock to begin with, the metal first upsets to a round and contacts tangentially the flat sides of the punch di cavity 98, and thereafter the metal fills the corners of this die cavity and tightly packs this die cavity.

In this second embodiment of the present invention, I have found that a critical factor in its operation during the first blow of the double blow header is that the across-the-flats width of the hexagonal cavity 98 in the punch die should be not greater than 1-1/2 times the diameter of the initial blank W. As in the first-described embodiment, the blank is restrained against buckling because of the support provided by the flats in the punch die cavity, so that the upsetting action can continue until the corners in the die cavity are filled.

When the necessary volume to form the finished head can be obtained from an unsupported length of stock not more than 2-1/2 times the diameter, and the cavity 98 has a width across-the-flats of no more than 1-1/2 times the stock diameter, the metal upsets successfully without folding. However, when the dimensions approach or slightly exceed these limits, perfect upsets can still be obtained by using the recess 103.

The front end of the sleeve member 90 in the cone tool engages the front end face 84 of the fixed die 80 before the header slide 87 has completed its first forward stroke, and before the stock 111 has bulged for enough to contact the flats of the cavity 98. Therefore, upon the continue forward movement of the header slide 87 toward the end of its stroke, the spring 96 becomes compressed further, as shown in Fig. 9. Also, since the punch 102 is moving in unison with the header slide 87 at this time, the punch moves forward in the punch die cavity 98 to complete the upsetting of the outer end 111 of the workpiece W. This over-travel of the header slide 87 and the punch 102 with respect to the sleeve member 90 is made possible by the lost motion connection provided by the stop pin 109 and the slot 108

in th sle ve member 90.

At the completion of the first forward strok of the header slid 87, the parts are in the position shown in Fig. 9. From this figure, it will be apparent that the workpiece W has been cold formed to provide a reduced diameter, round cross-section segment 110 at its inner end, a short, gradually increasing diameter section 112 just forward of the reduced diameter inner end 110, a somewhat longer cylindrical segment 113 joined to the front end of the segment 112, a short, enlarged cylindrical collar 114 seated in the counterbore 86 in the front end of the fixed die, and enlarged hexagonal head segment 115 in the punch die cavity 98, and a rounded, forwardly protruding segment 116 on the outer end face of the hexagonal head segment 115. This protruding segment 116 conforms snugly to the shape of the recess 103 in the front end of the punch 102, while the hexagonal head segment 115 conforms snugly to the punch die cavity 98 and the cylindrical collar 114 conforms snugly to the counterbore 86 in the front end of the fixed die 80.

As the reciprocatory header slide 87 is retracted following its first forward stroke, the spring 96 holds the sleeve member 90 of the cone tool forward against the front end face 84 of the fixed die 80 during the initial rearward movement of the header slide. After lost motion movement of the header slide 87 rearward with respect to the sleeve member 90, as determined by the length of the slot 109, the sleeve member 90 then begins to move rearward away from the fixed die 80. At this time the knock-out lever 107 is operated in its forward stroke to force the punch 102 forwardly with respect to the sleeve member 90. This forward movement of the punch 102 ejects the just-formed hexagonal head portion 115 on the workpiece from the punch die 97 and holds the remainder of the workpiece seated in the cavity in the fixed die 80, Thereaft r, th punch 102 retracts away from the workpiece, along with th

head r slide 87 and the sleeve member 90.

Bef r the second forward stroke of th header slid 87, the tool carrier 88 is shifted to move the cone tool 89 out of alignment with the blank and move the finish punch tool into position for engagement with the blank in the next forward stroke of the header slide. At the same time, the tool carrier 88 positions a knock-out lever 107', which is pivoted on a part 88b of the tool carrier, to the position shown in Fig. 10.

Referring now to Fig. 10, the tool carrier 88 carries the finish punch, designated in its entirety by the reference numeral 121. The finish punch tool includes a sleeve member 122 having an enlarged flange 123 on its front end. The sleeve member 122 is snugly received in a cylindrical bushing 124 carried by the tool holder 120.

At its front end the sleeve member 122 is formed with a cavity 125 in which is seated a punch die 126. The front end of the punch die defines a hexagonal cavity 127 corresponding in size to the finished head on the blank. A fixed hexagonal punch 128 is seated in the punch die presenting a front face 129 with a curvature complementary to the desired curvature of the end of the finished head on the blank. At its corners the punch presents forwardly protruding petals 129a which snugly fill the corners of the punch die cavity to prevent flashing of the blank material and also to produce the beveled corners on the cuter end of the finished hand.

A rigid backup plate 130 engages the back ends of the punch die 126 and the punch 128. The sleeve member 122 presents an inwardly protruding shoulder 131 at the back end of cavity 125, against which the plate 130 is seated. Behind this shoulder the sleeve member 122 has a bore 132 which l ads into an nlarg d ounterbore 133. A plat 134 is r c iv d in the back end of the bushing 124, engaging the back end of sl eve member 122. Plate 134 is form d with a passage 134a which

permits the forward movement of the knock-out lever 107'.

During the second forward stroke of the h ad r slid 87, the front end of th punch member 128 in the punch die 126 engages the protruding dimple 116 on the outer end of the hex head 115 and the front end of the punch die 126 surrounds the outer end of this hex head. As the header slide continues to move forward the dimple 116 is flattened into the hex head segment and the hex head segment itself is further upset to fill the punch die cavity 127. At the end of the second forward stroke of the header slide the front end 123 of the sleeve member 122 is engaging the front face 84 of the fixed die and the hex head on the workpiece is squeezed between the front face 84 of the fixed die 80, the side walls of the punch die cavity 127, and the rounded front end face 129 of the plug 128 in the punch die cavity.

Thereafter, the header slide 87 is retracted again, carrying with it the entire finish punch 121, which leaves the blank W seated in the fixed die 80. The knockout lever 107' is actuated at this time, but is ineffective. Its action is not necessary to maintain the blank seated in the fixed die 80. Then the knock-out pin 82 in the fixed die 80 is actuated forward to knock the finished blank W out of the die cavity.

Following this, and before the next forward stroke of the header slide 86, another length of wire stock is sheared off and is moved into position in front of the cavity in the fixed die 80, so that in the next forward stroke of the header slide this next blank is upset in the manner shown in Figs. 8 and 9.

This second embodiment of the invention is particularly suitable where the finished hex head is to have a cross-sectional size which is not particularly large compared to the original diameter of the blank. In such situations it is possible to upset the blank in the first blow almost the its final size, which is what takes place in the arrang ment shown in Figs. 8-11.

In one practical embodiment of the second form of the invention, the starting blank is a length of .305 inch diameter wire stock, the across-the-flats width of the upset head segment 115 after the first blow is about .460 inch, and the finished hex head has an across-the-flats width of about .495 inch and an axial length of about .193 inch.

It will be evident that the second embodiment operates upon essentially the same novel principles as the first, with the blank being upset in the first blow from round cross-section to the general polygonal shape desired in the finished head, while in the second blow the blank is further upset to the final shape, with the metal flowing in the same direction as in the first blow, but farther, in order to complete the cold formation of the head.

In both embodiments the amount of blank material required to make up the finished head is less than if the blank were upset to an enlarged round cross-section and then trimmed to the desired polygonal shape. For this reason, the present invention enables the unsupported length of the blank in the first blow to be shorter, which reduces the likelihood of buckling of this portion of the blank while it is being upset.

The finished blank has superior properties, the polygonal head being quite strong because of the absence of the re-entrant fold produced by the techniques common in the prior art. The finished head on the blank has flow lines throughout which are characteristic of the progressive upsetting of the blank twice in the same direction.

Figure 12 illustrates an axial section of a finished bolt blank in accordance with the present invention. The dotted lines in the blank illustrated there represent the flow lines in the blank, as revealed by etching the blank half along the axial section face wher th blank was cut in two. The blank was produced by th foregoing apparatus and method. As shown

in this Figure, the flow lines in the shank or st m portion of this blank are straight and run lengthwis of the blank, In the ups t head portion of the blank, the flow lines are curved in the same general direction as the head was upset, Near the axis of the blank the curvature of the flow lines is slight. The flow lines toward the radially outward edge of the head are progressively more curved in a gradual manner. Throughout the blank, and particularly in the head, there are no flow lines which would tend to weaken the blank appreciably.

While two presently-preferred embodiments of the apparatus and method of the present invention have been described herein, with reference to the accompanying drawings, it is to be understood that various modifications, omissions and refinements which depart from the disclosed embodiments may be adopted without departing from the spirit and scope of this invention. For example, the finished head may be square or any other polygonal shape other than hexagonal.

"The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:"

1. A double blow header comprising a work-receiving die adapted to receive an elongated blank with one end protruding therefrom, first and second tools operable to successively upset the protruding end of said blank to form a polygonal head thereon, said first tool including a sleeve formed with a uniform cross-section passage therein, and a polygonal cross-section punch closely fitting in said passage, mounting means mounting said sleeve for axial movement relative to said punch between the forward position toward said die and rearward positions spaced back from said forward position, means maintaining said sleeve in said forward position as said first tool moves toward said die until the end of said sleeve engages the end of said die, said sleeve and die cooperating to define a polygonal die cavity closed at the end face of said die before said punch completes its upsetting operation, said sleeve and die being fixed against relative movement and completely confining said protruding end during at least the final portion of upsetting by said first tool, said second tool being formed with a uniform cross-section polygonal die cavity having side and end walls fixed against relative movement during its entire upsetting operation on said protruding portion, the cross-section of said polygonal die cavity in said second tool being greater than the cross-section of said passage in said sleeve.

2. A double blow header according to claim 1 wherein said means maintaining said sleeve in said forward position as said first tool moves toward said die is r silient and maintains said sleeve in said forward position as said first tool moves

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toward said die until the end face of said sleev engages the end face of said die.

3. A double blow header according to claim 1 wherein is included a header slide movable toward and away from said work receiving die and wherein said work receiving die has a cavity for snugly receiving and holding a round cross-section blank, and said first and second tools are forming tools carried by said header slide for engagement alternately with a blank in the work receiving die and successive strokes in the header slide, said first forming tool being a cone tool including a first punch with a uniform cross-section polygonal die cavity facing toward said work receiving die which is larger in cross-section than the cavity in the work receiving die, said die cavity in the first punch die having a cross-sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head on the blank, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, means providing a lost-motion coupling between said first punch die and said header slide which limits the relative movement therebetween, and a cone punch extending snugly into said punch die cavity and mounted on the said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first strok for engagement with the blank to upset the blank during the completion of the forward movement of the header slide following the ngagement of the first punch die against the work

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receiving die, and means for moving the cone punch forward with respect to the first punch die as the header slide is retracted after its first stroke so as to strip the upset blank from said first punch die and hold the blank seated in the work-receiving die, and a second of said forming tools being a finished punch tool including a second punch die with a polygonal die cavity facing towards said work-receiving die which is larger in cross-section and of shorter depth axially than the die cavity of said first punch die, and a finish punch having an enlarged head in said second punch die, said head on the said finished punch having a polygonal front end which is received snugly in said second punch die at the inner end of the polygonal die cavity therein, said polygonal front end of the finish punch head presenting a rounded end face which faces forward into the die cavity in said second punch die and having forwardly projecting petals snugly received in the corners of the die cavity in said second punch die, said head on the finish punch behind its front end face having a back end which tapers rearwardly and laterally inwardly, rigid backing means engaging and supporting said tapered back end of the head on the finish punch completely across the latter's width, and said finish punch having a stem connected to and extending slidably through said rigid backing means, said finish punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to further upset the blank against the walls of said second punch die cavity, and means for moving said finish punch forward with respect to the second punch die as the header slide is retracted after its second

stroke so as to strip the upset blank from the second punch die and hold the blank seated in the work-receiving die.

4. In a double blow header which includes a work-receiving die having a cavity for snugly receiving and holding a round cross-section blank, a header slide movable toward and away from said work-receiving die, and first and second forming tools carried by said header slide for engagement alternately with a blank in the work-receiving die in successive strokes of the header slide, the improvement which comprises the first of said forming tools being a cone tool including a first punch die with a polygonal die cavity facing toward said work-receiving die which is larger in cross-section than the cavity in the work-receiving die, said die cavity in the first punch die having a cross-sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head on the blank, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, means providing a lost-motion coupling between the first punch die and the header slide which limits the relative movement between them, and a cone punch extending snugly into said punch die cavity and mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke for engagement of the first punch die against the blank during the completion of the forward movement of the header slide following the engagement of th first punch di against the work-receiving die, said first punch having a r cess in its end fac in said

punch for holding the end of the blank, and means for moving the cone punch forward with respect to the first punch die as the header slide is retracted after its first stroke so as to strip the upset blank from the first punch die and hold the blank seated in the work-receiving die, and the second of said forming tools being a finish punch tool including a second punch die with a polygonal die cavity facing toward said work-receiving die which is larger in cross-section and of shorter depth axially than the die cavity in said first punch die, and a polygonal finish punch seated in said second punch die, said finish punch having a polygonal front end which is received snugly in said second punch die at the inner end of the polygonal cavity therein, said polygonal front end of the finish punch presenting a rounded end face which faces into the die cavity in said second punch die and having forwardly projecting petals snugly received in the corners of the die cavity in said second punch die, rigid backing means engaging the back end of the finish punch completely across the latter's width, said finish punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to further upset the blank against the walls of said second punch die cavity.

5. A double blow header according to claim 1 wherein said second tool comprises a finish punch tool including a punch die having a polygonal die cavity therein, a punch having an enlarged head in said die, said head on the punch having a polygonal front end which is received snugly in the punch die at the inner nd of the polygonal cavity therein, said polyg nal front end of th punch head pr senting a rounded end fac which faces forward into the die cavity and having forwardly projecting petals snugly

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received in the corners of the die cavity, said head on the punch behind its fr nt end face having a back end which tapers rearwardly and laterally inwardly, and rigid backing means engaging and supporting said tapered back end of the head on the punch completely across the latter's width.

6. The apparatus of claim 5 wherein said punch has a stem connected to and extending rearwardly from the tapered end of said head, said stem extending slidably through said rigid backing means, and wherein there is provided means for moving said punch forward into said punch die cavity.

7. An apparatus according to claim 1 wherein one of said tools comprises an assembly formed with a uniform cross-section die cavity having side walls and a concave end wall extending inwardly therefrom to an axial bore, and a tool having a stem portion extending through said bore and an enlarged portion, said enlarged portion having a rearwardly facing surface proportioned to closely fit said concave end wall and a forwardly facing surface having forwardly projecting petals adjacent the corners of said side walls, the enlarged portion of said tool being supported against axial and radial forces by said concave end wall and being free for movement relative to said die assembly in a direction away from said concave end wall.

8. An apparatus according to claim 1 wherein said work-receiving die comprises a die having an extrusion throat proportioned to reduce the diameter of a portion of said stock, backup means preventing stock movement through said throat when a predetermined amount of stock is pass d therethrough s that a portion f the stock is upset into an intermediate head substantially filling said polygonal die cavity during the final

portion of the working stroke of said first tool, and wher in said first tool has a shallow guide recessed proportioned t laterally support one end of the stock of a blank as the other end is pressed through said throat during the first portion of the working stroke of said first tool, and wherein said second tool is formed with a uniform cross-section die cavity with side walls and an end wall in the shape of a finished head and said end wall of said second tool pressing the projection form by said recess into the upset head forming a smooth end on the finished blank.

9. A double blow header according to claim 1 wherein is included a header slide movable toward and away from said work receiving die and wherein said work receiving die has a cavity for snugly receiving and holding a round cross-section blank, and said first and second tools are forming tools carried by said header slide for engagement alternately with a blank in the work receiving die and successive strokes in the header slide, said first forming tool being a cone tool including a first punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross-section than the cavity in the work-receiving die, said die cavity in said first punch die having a cross sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head of the blank, and a first punch extending snugly into said punch die cavity for engagement with th blank to upset th blank against the walls of said punch di cavity in th first stroke of the header slide, and the s cond of said forming tools being a finished

punch tool including a second punch die with a polygonal die cavity substantially uniform cr ss section facing toward said work-receiving die which is larger in cross section and shorter in depth axially than the die cavity in said first punch die, and a finish punch die in said second punch die cavity for engagement with the blank to further upset the blank against the walls of said second punch die cavity in the next stroke of said header slide, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, and said first punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to upset the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, and a lost motion coupling between the first punch die and the header slide which limits the relative movement between them.

10. A double blow header according to claim 1 wherein is included a header slide movable toward and away from said work receiving die and wherein said work receiving die has a cavity for snugly receiving and holding a round cross-section blank, and said first and second tools are forming tools carried by said header slide for engagement alternately with a blank in the work receiving die and successive strokes in the header slide, said first forming tool being a cone tool including a first punch die with a polyg nal di cavity of substantially uniform cross section facing toward said

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work-receiving di which is larger in cross secti n than the cavity in the work-receiving die, said die cavity in said first punch die having a cross sectional size and an axial depth sufficient to accommodate a volume of blank material substantially equal to that required for the finished polygonal head of the blank, and a first punch extending snugly into said punch die cavity for engagement with the blank to upset the blank against the walls of said punch die cavity in the first stroke of the header slide, and the second of said forming tools being a finished punch tool including a second punch die with a polygonal die cavity of substantially uniform cross section facing toward said work-receiving die which is larger in cross section and shorter in depth axially than the die cavity in said first punch die and a finish punch in said punch die cavity for engagement with the blank to further upset the blank against the walls of said second punch die cavity in the next stroke of said header slide, said first punch die being yieldably mounted on said header slide to project toward said work-receiving die and to engage said work-receiving die prior to the completion of the forward movement of the header slide in its first stroke, and said first punch being mounted on said header slide to move as a rigid unit therewith throughout the forward movement of the header slide in its first stroke so as to upset the blank during the completion of the forward movement of the header slide following the engagement of the first punch die against the work-receiving die, and means are provided for moving the first punch forward with respect to the first punch die as the header slide is retracted after the first stroke so as to strip the blank from the first punch die and hold th blank seated in the

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work-receiving di .

11. An apparatus according to claim 1 wherein one of said tools comprises an assembly formed with a uniform cross-section die cavity having side walls and a conical end wall extending inwardly therefrom to an axial bore, and a tool having a stem portion extending through said bore and an enlarged portion, said enlarged portion having a rearwardly facing conical surface proportioned to closely fit said conical end wall and a forwardly facing surface having forwardly projecting petals adjacent the corners of said side walls, the enlarged portion of said tool being supported against axial and radial forces by said conical end wall and being free for movement relative to said die assembly in a direction away from said conical end wall.

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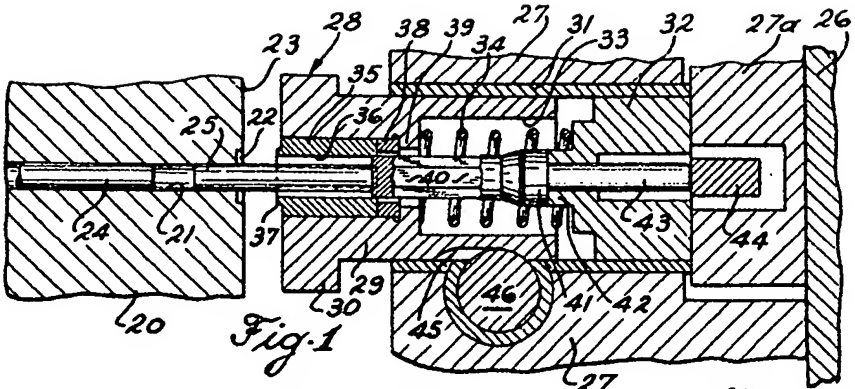

Fig. 1

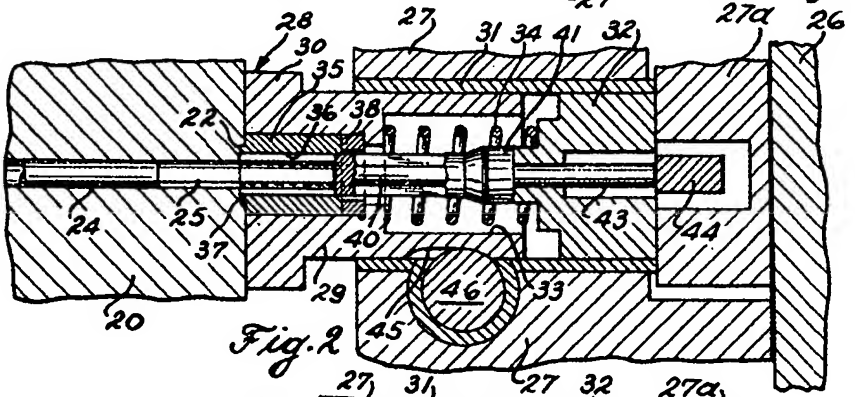

Fig. 2

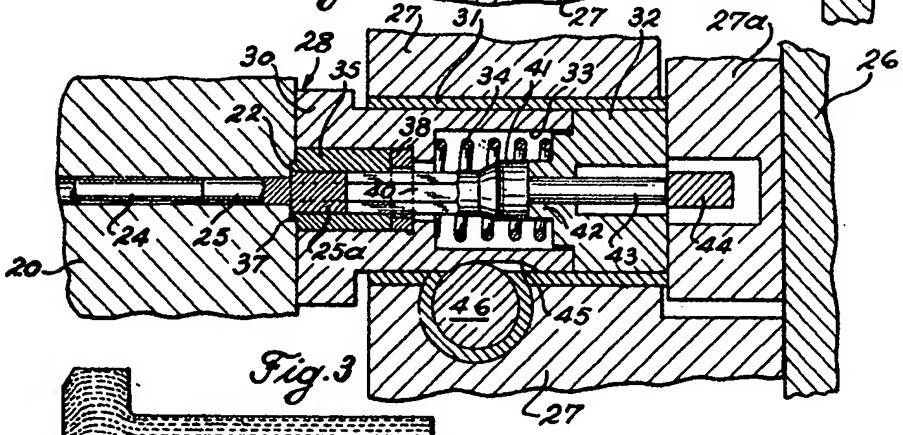

Fig. 3

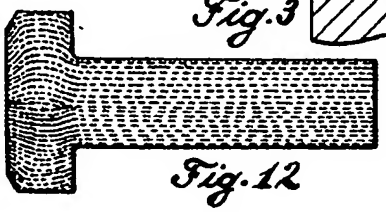

Fig. 12

Inventor

Robert G. Friedman

Patent Agents

Alex. E. MacRae & Co.

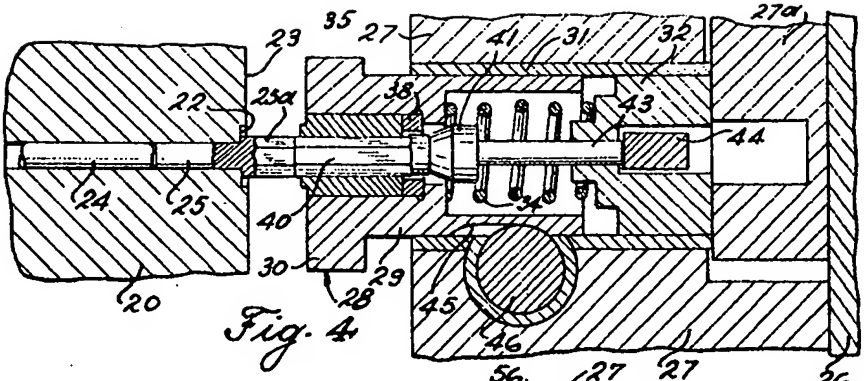

Fig. 4

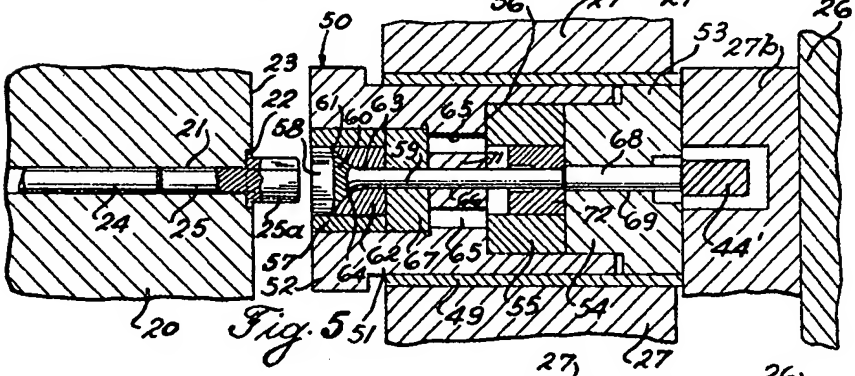

Fig. 5

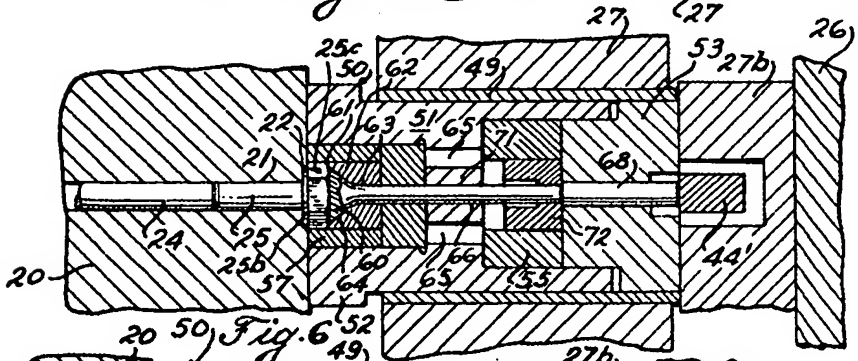

Fig. 6

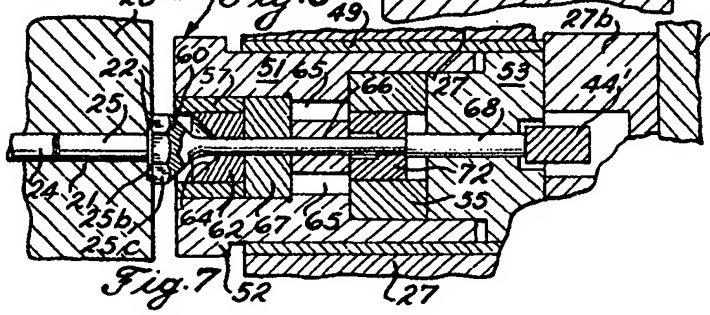

Fig. 7

Inventor

Robert C. Friedman

Patent Agents

Allen E. MacLachlan Co.

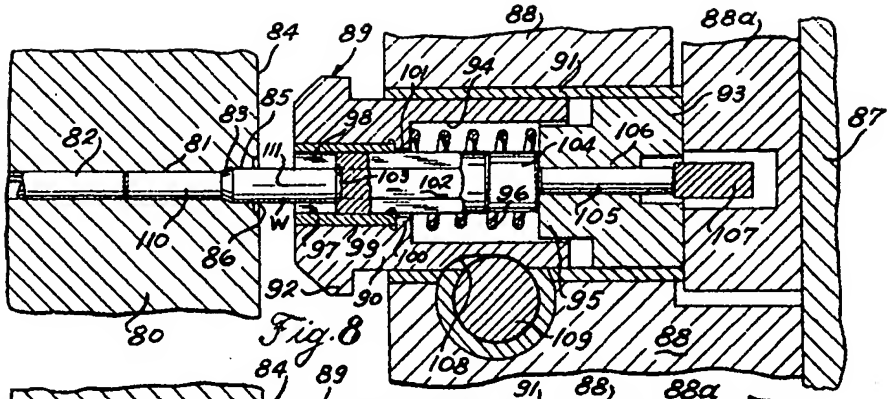

Fig. 8

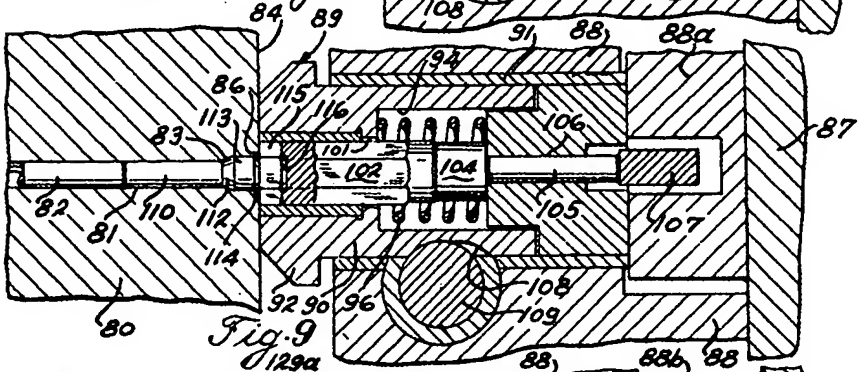

Fig. 9

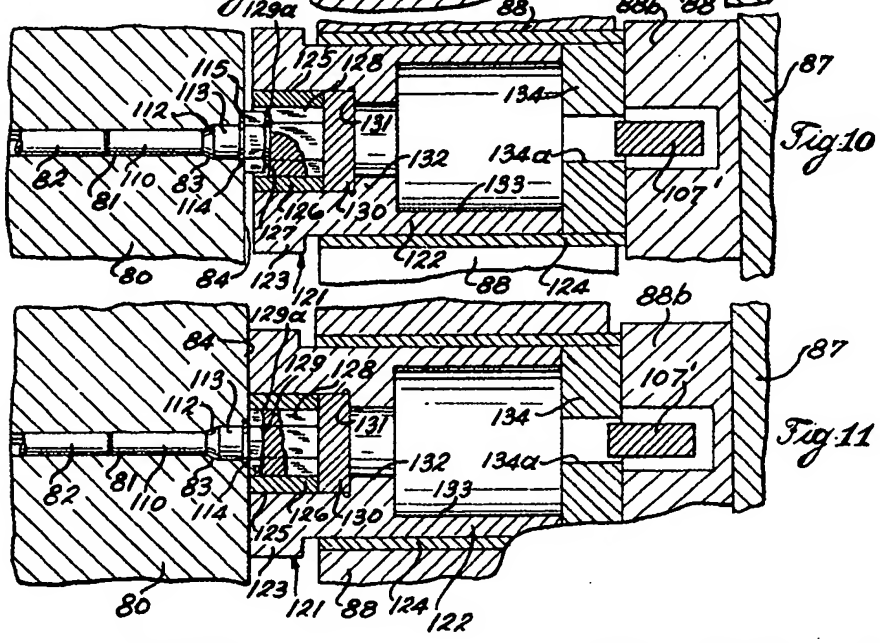

Fig. 10

Fig. 11

Inventor

Robert G. Friedman

Patent Agents

Alex. E. MacRae & Co.